



EVALUATING PURE NEOCLASSICAL WAGE EXPLOITATION AMONG WORKFORCE DIFFERENTIATED BY GENDER AND OCCUPATIONS IN SINGAPORE

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ABSTRACT

The exploitation of workers can have disastrous consequences for society since their employers' wage exploitation may adversely influence living standards. Under such circumstances, the percentage of poverty and crime would rise. Due to the importance of adverse impacts of wage exploitation on workers' livelihoods, this study analyzes the concept of pure exploitation in Singapore during the period from 2011 to 2018.

To accomplish this aim, the marginal revenue product (MRP) and average revenue product (ARP) of the gender and occupational groups defined by this study are compared to the groups' wages. The existence of pure exploitation among the groups, according to the obtained results, has been demonstrated.

The findings also indicate that the female groups' degree of wage exploitation has been more significant than the male groups' figure.

1. Introduction

All people generally tend to find a job or set up their own business to generate earnings to satisfy their needs. Furthermore, employers need to hire workers to manufacture their products. Thus, what can play a paramount role in the labor and product markets' wages is the wages of labor in that any change in wages may affect not only the employment rate but also the profits of firms (Cahuc et al., 2014; Katovich and Maia, 2018). Hence many firms tend to exploit their workers to make huge profits. Under such circumstances, the winners of the labor and product markets are employers exploiting workers. In contrast, the losers of the markets are workers since workers' exploitation can have adverse impacts on the workers' livelihoods. The workforce's exploitation generally occurs when the labor market or the product market is imperfectly competitive or monopolistic (Robinson, 1933).

The particular kind of exploitation that has historically engaged many economists is wage exploitation. Wage exploitation occurs when workers' wages are lower than the optimal wages paid to them for their work. Consequently, their employers could unfairly benefit from them. As stated above, many economists have conducted studies to find the main causes of wage exploitation. For instance, Smith's view (1776) about wage exploitation was ambiguous since he demonstrated that supply and demand laws could protect wages' justice. He noted that the characteristics of the labor market lead to imperfect competition in the market, thereby creating an uneven playing field in favor of capitalist profits and against workers' wages. Accordingly, Smith had two views about the product market and labor market since the competitive equilibrium could be preserved in most commodities. In contrast, the labor market tends away from competitive conditions (Fairlamb, 1996).

Marx's exploitation theory (1867) is considered a critical exploitation theory and could be a cornerstone of Marxist thought. According to Marx's view, workers would be exploited in the capitalist system based on the surplus-value theory of wages. In contrast to capitalist theories, he assumed that the population could not drive wages to the subsistence level (the minimum wages required for basic needs such as food and shelter). The tendency in the capitalist system to chronic unemployment and the existence of an industrial reserve army bring wages to the subsistence level. Hence the owners of capital could exploit their workers to produce more output, and the profits, which are created by the excess product or surplus-value, are only distributed among the owners (Reeve, 1987). Owing to the existence of labor exploitation in the capitalist system, he propounded a theory to redistribute the wealth of countries for eliminating economic inequality in societies. Based on the theory, workers' wages should be determined not only by the hours of labor spent to produce a product but also by their needs (Elster, 1978).

Nevertheless, Marx's exploitation theory has been rejected by many economists since he ignored the risk of capital investment and the efforts of management. For example, Steele (1992) demonstrated that Marx's exploitation theory is untenable due to the marginal labor productivity theory of wages developed by Wicksteed (1894) and Clark (1899). According to the theory, workers' wages would be determined by their contributions to marginal output, provided the labor and product markets were competitive. Therefore wages would equal the marginal labor productivity in an optimum situation. Furthermore, the capital owners' share of profits should be determined by the marginal productivity of their

capital's contribution to marginal output. Thus, Steele assumed that wage exploitation would occur, providing wages lower than marginal labor productivity. However, the marginal labor productivity theory of wages pivots on the existence of perfect competition in markets and emphasizes the demand aspects of the labor market, neglecting the supply aspects.

Despite the advantages of the theory of marginal labor productivity, using the theory to assess wage exploitation may be inconsistent with the real world due to the lack of an optimum situation (perfect competition) in markets. Moreover, the theory is one-sided, taking account of the demand side of labor and ignoring the supply side. Since the exploitation theory could not consider the demand and supply aspects of the labor market simultaneously, Pigou (1920) propounded an exploitation theory based on the modern theory of wages developed by Marshall (1890). In the contemporary theory of wages, workers' wages are determined by the interaction of labor supply and demand. According to the theory, the exploitation of labor occurs when workers are paid less than the value of their marginal net product (Collins et al., 2018). Pigou demonstrated that exploitation is one of two primary sorts of unfair wages. The first class of unfair wages that does not involve exploitation occurs when some workers cannot change their occupations due to the costs of movement and ignorance. Hence the value of their marginal product is low in comparison with that of workers who can select their occupations freely. Furthermore, the existence of monopolistic conditions in the labor market could result in Pigou's second class of unfair wages that is attributable to exploitation. Under such circumstances, workers' wages can be affected on account of a disparity between the bargaining power of employers and that of workers. Therefore a range of indeterminateness in wages may be caused. The upper limit of the range is a wage that is equal to the value of the marginal product. In contrast, the lower limit is a wage that is equal to the expected wage that could be obtained by moving elsewhere, minus an allowance to balance the costs of the movement (Daniel, 1990).

Robinson (1933) employed Pigou's definition of exploitation as a payment that is less than the marginal product's value to identify the main causes of wage exploitation (Collins et al., 2018). The fundamental causes of exploitation, in her view, include monopolistic exploitation and monopsonistic exploitation. The monopolistic exploitation could occur when the product market is imperfectly competitive, even if labor supplies are perfectly elastic. Furthermore, the bilateral monopoly that may arise from the existence of strong employer associations and strong labor organizations leads to monopsonistic exploitation due to the imperfect elasticity of labor supply (Heller, 1998). In addition to the causes of exploitation, based on Robinson's study, employers' discriminatory power could result in labor exploitation, occurring when a group of employers occupies a very strong monopolistic position compared with labor. Employers' discriminatory power can be categorized into monopsonistic exploitation since the labor market is imperfectly competitive in the situation (Bhaskar et al., 2002; Staiger et al., 2010; Ashenfelter et al., 2010).

Nevertheless, Chamberlin's view (1933) as regards monopolistic exploitation propounded by Robinson was different. Notwithstanding the similarities in their imperfect and monopolistic competition accounts, Chamberlin believed that wages paid to workers should be less than the value of their marginal product. Since not only is it unprofitable for the imperfectly competitive product markets, but it is also impossible to do so in the long-run equilibrium when the price is higher than marginal revenue and equal to average costs. Thus, he concluded that workers should necessarily be exploited when the product market is imperfectly competitive or monopolistic to prevent firms from going bankrupt (Collins et al., 2018). Due to Chamberlin's critique, many economists have ignored monopolistic exploitation in their studies and have only considered the possibility of monopsonistic exploitation example, Bloom (1941). Wage exploitation, according to the studies, would occur, provided the MRP exceeded the wage rate. Nonetheless, the condition in which the wage rate is lower than the MRP is not sufficient for monopsony profit in the employment of labor in that one of the profit maximization conditions is to choose a rate of use of labor so that the MRP equals the marginal factor cost of labor providing that the ARP of labor exceeds the wage rate. Therefore, the ARP's neglect to identify labor exploitation could result in an incorrect assessment (Daniel, 1990).

Daniel (1990) introduced pure exploitation due to the deficiencies in the definition of labor exploitation presented in the studies mentioned above. Based on the study, pure exploitation occurs when a worker's contribution to a firm's revenue exceeds their wage. In contrast, the firm receives an economic profit as a result of the worker's employment. He demonstrated that there would be a necessary and sufficient condition to evaluate general monopsonistic exploitation with monopsony profit, provided the marginal factor cost of labor, which is equal to the MRP, and the ARP simultaneously exceeded the wage rate.

Due to the detrimental impacts of labor exploitation on workers' welfare, this study evaluates pure exploitation among the workforce differentiated by gender and occupations in Singapore during the period from 2011 to 2018. To accomplish this aim, the study introduces a production function under the assumption that labor is heterogeneous to compute the MRP and ARP of the female and male workforce working in high-level and low-level occupations. The existence of pure exploitation among the workers is evaluated in three steps. First, the production function developed by the study is estimated during the period 1980-2018 to obtain coefficients and parameters required for calculating the MRP of the investigated workforce. Second, the derivative of the production function concerning the female and male workers in high-level and low-level occupations is taken separately to develop four equations for computing the MRP of the workers. Finally, after the calculations, wages paid to the workers are compared to their MRP and ARP to evaluate pure labor exploitation in Singapore between 2011 and 2018.

The remainder of the paper is organized as follows: The theoretical literature is reviewed in Section 2, and section 3 introduces the model, methodology, and data of the study. Section 4 discusses the empirical results. Finally, section 5 concludes the relevant remarks.

2. Literature Review

Based on the neoclassical theory of exploitation, labor exploitation can be expounded by the profit function of a firm. It is presumed that the firm has two different profit functions in the short run and long run. The only variable factor that can affect the output of the firm in the short term is labor ($q=F(L)$). Accordingly, the profit function of the firm in the short run is written as follows:

$$\pi = TR_L - FC_L = (P \times F(L)) - (W \times L) \quad (1)$$

where $TR_L = P \times F(L)$ is the revenue product of labor. Hence P and $F(L)$ denote the price of the output and the net physical product of labor, respectively. $FC_L = W \times L$ refers to the factor cost of labor because W and L are respectively the wage rate and the rate of use of labor. The first-order condition for the maximization of the profit function can be expressed as follows:

$$\begin{aligned} d(TR_L)/dL - d(FC_L)/dL &= 0 \\ [P \times d(F(L))/dL + F(L) \times dP/dL] - [W + L dW/dL] \\ MRP_L &= MFC_L \end{aligned} \quad (2)$$

where MRP_L is the MRP of labor, and MFC_L is the marginal factor cost of labor. It is assumed that Equation (1) is concave according to the neoclassical theory. The firm could thus maximize its profit through selecting a rate of use of labor so that $MRP_L = MFC_L$ provided that $W \leq (TR_L/L) = ARP_L$, where ARP_L denotes the ARP of labor. Moreover, owing to the perfect competition in the labor and product markets, the firm exerts influence over neither the price of its product nor the wage rate of labor. In other words, $dP/dL = (dP/d(F(L))) \times (d(F(L))/dL) = 0$ and $dW/dL = 0$. Consequently, the value of the marginal product of labor ($VMP_L = P \times d(F(L))/dL = P \times MP_L$ where MP_L is the marginal physical product of labor) equals the wage rate. Accordingly, when the labor and product markets are perfectly competitive, the firm would choose the optimal rate of use of labor, providing $MRP_L = VMP_L = W = MFC_L$. Thus, Pigou (1920) and Robinson (1933) asserted that labor exploitation would not occur in competitive conditions.

On the other hand, as stated by Robinson (1933), the existence of imperfect competition in the product market even if the labor market is perfectly competitive would result in monopolistic exploitation since $dP/d(F(L)) < 0$ and $d(F(L))/dL > 0$. In the situation, the value of the marginal product of labor exceeds the MRP of labor, the marginal factor cost of labor, and the wage rate. The gap between VMP_L and the wage rate implies the occurrence of monopolistic exploitation. Conversely, Chamberlin's view (1933) concerning monopolist exploitation was significantly different from that of Robinson. He demonstrated that the wage rate should be less than the value of the marginal product of labor when the product market is imperfectly competitive since the imperfect competition leads to an inverse relationship between the average revenue, which equals price, and the output. Therefore the marginal revenue is less than price, and all factors utilized in the production process are paid less than the value of their marginal products. Thus, it is not profitable for firms to pay the wages of their workforce according to the value of their marginal products when the demand for their products is not perfectly elastic. Moreover, the firms cannot pay their workforce the value of their marginal products in the long run because new firms can enter the product market freely to profit from the market. Hence the firms may go bankrupt if they do not take account of the price of their product, which equals average costs in the long term.

Furthermore, another cause of labor exploitation mentioned by Pigou and Robinson is the existence of imperfect competition in the labor market. The cause is also known as monopsonistic exploitation. Employer associations and labor organizations can influence the price of labor when the labor market is imperfectly competitive as the supply curve of labor is not elastic. Hence $dW/dL > 0$ that means a rise in the wage rate can increase the supply of labor. In the situation, if the firm, whose profit function explained in Equation (1), sells its products competitively, it follows that $MRP_L = VMP_L = MFC_L > W$ owing to $dW/dL > 0$. Thus, the gap between MFC_L and the wage rate would indicate monopsonistic exploitation. Since it is assumed that the product market is perfectly competitive, the exploitation is not subject to Chamberlin's critique.

In comparison with monopolistic exploitation and monopsonistic exploitation, double exploitation, which occurs when there is imperfect competition in the product market (monopoly) and in the labor market (monopsony), is prevalent in different economies. It follows that $VMP_L > MRP_L = MFC_L > W$ as a result of double exploitation. However, due to Chamberlin's critique, the gap between VMP_L and the wage rate cannot be considered as double exploitation. Therefore the exploitation can be defined by the gap between MFC_L and the wage rate.

Nevertheless, it is expected that a rising supply price for labor, which is the crucial determinant of general neoclassical monopsonistic exploitation, is a temporary supply condition in labor markets and therefore not sufficient for monopsony profit. Thus, the occurrence of rising supply prices for labor, which is prevalent in the short run, does not imply that employers enjoy an economic profit (unearned income) made by employing labor (Daniel, 1990). To evaluate the accurate exploitation of labor, general monopsonistic exploitation, which occurs when the wage rate is less than a worker's contribution to the revenue of a firm, and monopsony profit, which is a consequence of the employment of labor, should be considered simultaneously. Hence Daniel (1990) propounded pure exploitation that occurs when monopsonistic exploitation is concurrent with monopsony profit in a firm. Assuming profit-maximizing behavior on the part of firms (so that $MRP_L = MFC_L$), pure exploitation can occur when $MRP_L = MFC_L > W$ and $ARP_L > W$.

Even though the only variable input in the short-term profit function shown in Equation (1) is labor, capital that is another factor affecting the output can be variable in the long run. Therefore, the long-term production function should be considered with labor and capital. Moreover, it is assumed that labor is homogenous while the assumption can be incorrect since the occupations and gender of workers can affect their wages. Thus, the employers may determine the wage rate of each group through its MRP_L and ARP_L according to the theory of pure exploitation. The profit function of the firm in the long run under the assumption that workers are differentiated by their occupations and gender can be as follows:

$$\pi = TR - FC = (P \times F(L_{FH}, L_{FL}, L_{MH}, L_{ML}, K)) - (W_{FH} \times L_{FH}) - (W_{FL} \times L_{FL}) - (W_{MH} \times L_{MH}) - (W_{ML} \times L_{ML}) \quad (3)$$

where $F(L_{FH}, L_{FL}, L_{MH}, L_{ML}, K)$ is the net physical product. L_{FH} and L_{FL} are female workers in high-level and low-level occupations. L_{MH} and L_{ML} are male workers in high-level and low-level occupations. W_{FH} and W_{FL} refer to the wage rates of female workers in high-level and low-level occupations. W_{MH} and W_{ML} are the wage rates of male workers in high-level and low-level occupations. K denotes physical capital stock. Consequently, to evaluate pure exploitation in the long run, the MRP and ARP of each group of the mentioned workers should be separately computed. Hence their MRP and ARP are as follows:

$$MRP_{L_{FH}} = \partial(TR) / \partial L_{FH} \quad (4)$$

$$MRP_{L_{FL}} = \partial(TR) / \partial L_{FL} \quad (5)$$

$$MRP_{L_{MH}} = \partial(TR) / \partial L_{MH} \quad (6)$$

$$MRP_{L_{ML}} = \partial(TR) / \partial L_{ML} \quad (7)$$

$$ARP_{L_{FH}} = TR / L_{FH} \quad (8)$$

$$ARP_{L_{FL}} = TR / L_{FL} \quad (9)$$

$$ARP_{L_{MH}} = TR / L_{MH} \quad (10)$$

$$ARP_{L_{ML}} = TR / L_{ML} \quad (11)$$

Thus, the investigated workers, according to the concept of pure exploitation, would be exploited if their MRP and ARP exceeded their wages.

3. Model, Methodology, and Data

A production function is proposed in this section to compute the MRP and ARP of female and male workers in high-level and low-level occupations. Based on Equation (3), the net physical product is a function of capital and labor, assumed to be heterogeneous. Hence the study employs the Cobb-Douglas production function, whose labor input takes the form of the nested constant elasticity of substitution (CES) function. A glance at Fig. 1 reveals the production structure scheme under the assumption that labor is differentiated by gender and occupations. As shown in the figure, workers are stratified by their gender (female and male workers), and the gender groups are also categorized into high-level and low-level occupations. The labor input is assumed to be heterogeneous across but homogeneous within the defined groups of workers. Thus, contrary to heterogeneous workers, it is assumed that the homogeneous workers (e.g., female workers in high-level occupations) are perfectly substitutable.

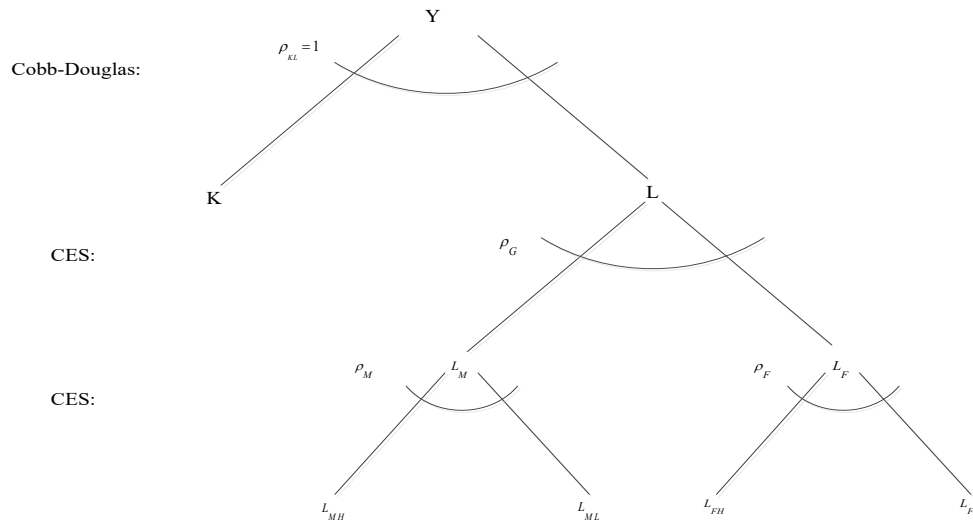


Fig: 1 The scheme of the production structure

Based on Fig:1, the study employs the following model to estimate the production function.

$$Y = AK^{\alpha_1} \left((\gamma(\delta_{FH} L_{FH}^{-\rho_F} + (1-\delta_{FH}) L_{FL}^{-\rho_F})^{\rho_F} + (1-\gamma)(\delta_{MH} L_{MH}^{-\rho_M} + (1-\delta_{MH}) L_{ML}^{-\rho_M})^{\rho_M})^{\frac{\rho_G}{\rho_G - \alpha_2}} \right) \quad (12)$$

where A is a Hicks neutral technological progress. and are the distribution parameters, and denote the substitution parameters. The equations of the MRP of the investigated groups can be obtained by taking the derivate of the production function with respect to, and if Y is considered as total revenue. Hence the MRP of the groups can be written as follows:

$$MRP_{L_{FH}} = AK^{\alpha_1} \left(-\frac{\alpha_2}{\rho_G} \right) \gamma \left(\frac{\rho_G}{\rho_F} \right) \delta_{FH} (-\rho_F) L_{FH}^{-(\rho_F+1)} (\delta_{FH} L_{FH}^{-\rho_F} + (1-\delta_{FH}) L_{FL}^{-\rho_F})^{\rho_F} \times \left((\gamma(\delta_{FH} L_{FH}^{-\rho_F} + (1-\delta_{FH}) L_{FL}^{-\rho_F})^{\rho_F} + (1-\gamma)(\delta_{MH} L_{MH}^{-\rho_M} + (1-\delta_{MH}) L_{ML}^{-\rho_M})^{\rho_M})^{\frac{\rho_G}{\rho_G - \alpha_2 - 1}} \right) \quad (13)$$

$$MRP_{L_{FL}} = AK^{\alpha_1} \left(-\frac{\alpha_2}{\rho_G} \right) \gamma \left(\frac{\rho_G}{\rho_F} \right) (1-\delta_{FH}) (-\rho_F) L_{FL}^{-(\rho_F+1)} (\delta_{FH} L_{FH}^{-\rho_F} + (1-\delta_{FH}) L_{FL}^{-\rho_F})^{\rho_F} \times \left((\gamma(\delta_{FH} L_{FH}^{-\rho_F} + (1-\delta_{FH}) L_{FL}^{-\rho_F})^{\rho_F} + (1-\gamma)(\delta_{MH} L_{MH}^{-\rho_M} + (1-\delta_{MH}) L_{ML}^{-\rho_M})^{\rho_M})^{\frac{\rho_G}{\rho_G - \alpha_2 - 1}} \right) \quad (14)$$

$$MRP_{L_{MH}} = AK^{\alpha_1} \left(-\frac{\alpha_2}{\rho_G} \right) (1-\gamma) \left(\frac{\rho_G}{\rho_M} \right) \delta_{MH} (-\rho_M) L_{MH}^{-(\rho_M+1)} (\delta_{MH} L_{MH}^{-\rho_M} + (1-\delta_{MH}) L_{ML}^{-\rho_M})^{\rho_M} \times \left((\gamma(\delta_{FH} L_{FH}^{-\rho_F} + (1-\delta_{FH}) L_{FL}^{-\rho_F})^{\rho_F} + (1-\gamma)(\delta_{MH} L_{MH}^{-\rho_M} + (1-\delta_{MH}) L_{ML}^{-\rho_M})^{\rho_M})^{\frac{\rho_G}{\rho_G - \alpha_2 - 1}} \right) \quad (15)$$

$$MRP_{L_{ML}} = AK^{\alpha_1} \left(-\frac{\alpha_2}{\rho_G} \right) (1-\gamma) \left(\frac{\rho_G}{\rho_M} \right) (1-\delta_{MH}) (-\rho_M) L_{ML}^{-(\rho_M+1)} (\delta_{MH} L_{MH}^{-\rho_M} + (1-\delta_{MH}) L_{ML}^{-\rho_M})^{\rho_M} \times \left((\gamma(\delta_{FH} L_{FH}^{-\rho_F} + (1-\delta_{FH}) L_{FL}^{-\rho_F})^{\rho_F} + (1-\gamma)(\delta_{MH} L_{MH}^{-\rho_M} + (1-\delta_{MH}) L_{ML}^{-\rho_M})^{\rho_M})^{\frac{\rho_G}{\rho_G - \alpha_2 - 1}} \right) \quad (16)$$

The ARP of the groups can also be expressed as follows:

$$ARP_{L_{FH}} = Y/L_{FH} \quad (17)$$

$$ARP_{L_{FL}} = Y/L_{FL} \quad (18)$$

$$ARP_{L_{MH}} = Y/L_{MH} \quad (19)$$

$$ARP_{L_{ML}} = Y/L_{ML} \quad (20)$$

According to Equations (14), (15), and (16), to compute the marginal revenue of the groups, the coefficients and parameters of Equation (12) are required. Hence the following model can be estimated to obtain the coefficients and parameters.

$$\begin{aligned} \ln(GDP_{it}) = & \alpha_0 + \alpha_1 \ln(K_{it}) - \frac{\alpha_2}{\rho_G} \ln(\gamma(\delta_{FH} L_{FH_{it}}^{-\rho_F} + (1-\delta_{FH}) L_{FL_{it}}^{-\rho_F})^{\frac{\rho_G}{\rho_F}} \\ & + (1-\gamma)(\delta_{MH} L_{MH_{it}}^{-\rho_M} + (1-\delta_{MH}) L_{ML_{it}}^{-\rho_M})^{\frac{\rho_G}{\rho_M}}) + \varepsilon_{it} \end{aligned} \quad (21)$$

where GDP_{it} is the gross domestic product (GDP) of country i at time t in constant 2010 U.S. dollars. K_{it} represents the gross capital formation of country i at time t in constant 2010 U.S. dollars. $L_{FH_{it}}$ and $L_{FL_{it}}$ denote the female workers in high-level and low-level occupations in country i at time t . $L_{MH_{it}}$ and $L_{ML_{it}}$ are the male workers in high-level and low-level occupations in country i at time t . ε_{it} is the error term.

It is reiterated that the main aim of this study is to evaluate pure exploitation among the defined working groups in Singapore during 2011-2018. To fulfill the aim, the study utilizes the nonlinear least squares (NLS) to estimate the coefficients and parameters of Equation (21). After the estimations, Equations (13), (14), (15), and (16) can be solved. Finally, the results of the equations and Equations (17), (18), (19), and (20) are compared to the annual mean rates of wages of the defined groups to evaluate labor exploitation among the workers.

This study uses annual data during the period from 1980 to 2018 to estimate Equation (21) and annual data during 2011-2018 for evaluating pure exploitation. Data on GDP_{it} and K_{it} are collected from the World Bank Group (WBG), and data on the other variables of Equation (21) and the annual mean rates of wages of the defined groups are from the International Labor Organization (ILO).

4. Empirical Results

The empirical analysis generally begins by investigating the characteristics of time series for regression variables. Therefore, before estimating Equation (21), the unit root test is done to evaluate the stationarity of the variables using the Augmented Dickey-Fuller (ADF) test (1981) and Stata 16 software. The results of this test are shown in Table 1.

Table 1: The results of the ADF test for the variables of Equation (21)

Variable	Test statistics	Probability value
$\ln(GDP_{it})$	-2.11	0.23
$D\ln(GDP_{it})$	-5.01	0.00
$\ln(K_{it})$	-0.60	0.86
$D\ln(K_{it})$	-8.12	0.00
$L_{MH_{it}}$	-0.59	0.87
$DL_{MH_{it}}$	-6.51	0.00
$L_{ML_{it}}$	-1.25	0.65
$DL_{ML_{it}}$	-5.31	0.00
$L_{FH_{it}}$	1.48	0.99
$DL_{FH_{it}}$	-8.51	0.00
$L_{FL_{it}}$	-2.38	0.14

$DL_{FL_{it}}$	-6.31	0.00
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Source: The research findings.

According to Table 1, all variables investigated in Table 1 are stationary in the first difference form. Since the variables are not stationary at level, the co-integration test should be carried out to assess the long-run relationship among the variables. Hence the Augmented Engle-Granger (AEG) test (1987) is selected for the co-integration test as all of the variables are stationary at first difference. The ADF test for the residuals obtained by the estimation of Equation (21) ought to be done to carry out the AEG test. The result of the test obtained by Stata 16 software is shown in Table 2.

Table: 2 The result of the ADF test for the error term of Equation (21)

Variable	Test statistics	Probability value
ε_{it}	-5.20	0.00

Source: The research findings.

The result demonstrates that the variables of Equation (21) are co-integrated. Consequently, the regression is not spurious, and its coefficients and parameters can be estimated by the NLS method. Table 3 shows the estimations obtained by Stata 16 software.

Table: 3 The estimation results of Equation (21)

Coefficients and parameters	Equation 21	Test statistics
α_0	22.35	9.43**
α_1	0.15	4.28**
α_2	1.48	6.66**
ρ_G	2.02	3.66**
ρ_F	1.61	2.96**
ρ_M	0.30	1.96*
γ	0.76	14.15**
δ_{FH}	0.69	8.78**
δ_{MH}	0.70	10.66**

Source: The research findings.

Note: ** and * denote the levels of statistical significance at 1% and 10%.

As shown in Table 3, all the coefficients and parameters of Equation (21) are statistically significant. Hence the MRP of the investigated groups can be computed by solving Equations (13), (14), (15), and (16) using the coefficients and parameters. Table 4 shows the values of the MRP of the groups during the period from 2011 to 2018

Table: 4 The values of the MRP of the investigated groups in Singapore, 2011-2018

Year	$MRP_{L_{FH}}$	$MRP_{L_{FL}}$	$MRP_{L_{MH}}$	$MRP_{L_{ML}}$
2018	397620.10	315418.87	75654.61	49730.61
2017	413225.30	296649.73	73533.52	46483.87
2016	439053.94	250391.31	58913.52	40593.93
2015	433275.85	242803.36	72105.53	42692.36
2014	446697.82	232941.68	68642.14	38439.62
2013	457828.89	215431.47	63892.37	35688.22
2012	467847.97	198610.49	61401.33	33255.51
2011	442645.03	205099.39	59647.17	32066.71

Source: The research findings.

The results of Table 4 indicate that the figure for the female groups has been considerably greater than that of the male groups. Moreover, the workers in high-level occupations have surpassed the other investigated workers in terms of the MRP. Furthermore, as stated earlier, the values of the ARP of these groups are required to evaluate pure exploitation. Therefore, the values for the groups calculated by Equations (17), (18), (19), and (20) are shown in Table 5.

Table 5: The values of the ARP of the investigated groups in Singapore, 2011-2018

Year	$ARP_{L_{FH}}$	$ARP_{L_{FL}}$	$ARP_{L_{MH}}$	$ARP_{L_{ML}}$
2018	588709.23	731983.24	471762.25	655570.62
2017	592783.80	709386.19	466242.25	628713.64
2016	638663.31	699779.40	450046.59	648470.89

2015	586292.59	638098.07	453056.42	580925.28
2014	598025.09	633164.62	452981.34	556465.27
2013	605164.66	615987.87	443389.87	543610.50
2012	596247.64	583439.16	429159.86	513831.94
2011	575749.87	582594.63	419054.25	498878.02

Source: The research findings.

The findings of Table 5 reveal that the values in all the years shown have been lower for the male workers than for the female workers. The figure in most of the investigated years for female and male workers with low-level occupations has exceeded that of both gender groups with high-level occupations. Now that the MRP and ARP of the gender groups have been calculated, their values can be compared to the annual mean rates of wages paid to the defined groups to evaluate pure exploitation among the workers. Hence the annual mean rates of real wages in constant 2010 U.S. dollars for the defined gender and occupational groups are shown in Table 6.

Table 6: The annual mean rates of real wages of the groups in Singapore, 2011-2018

Year	$Wage_{FH}$	$Wage_{FL}$	$Wage_{MH}$	$Wage_{ML}$
2018	56442.54	16971.63	63316.81	19124.54
2017	53326.77	15953.95	60232.17	17704.75
2016	52652.92	15321.47	58356.93	17560.23
2015	51245.03	14602.84	57489.54	16860.67
2014	53140.73	15362.56	60467.77	17824.42
2013	50010.63	14682.13	57754.09	18099.65
2012	47998.10	14094.84	55085.45	17208.34
2011	47533.54	14061.53	53888.02	17397.46

Source: The ILO, calculated by the author.

According to table 6, a yawning gap between workers' wages in high-occupations and those of workers in low-level occupations during the period under review has existed. Nevertheless, as shown in tables 4 and 5, the MRP of the gender groups in high occupations has been greater than that of the groups in low-level occupations despite a relatively narrow gap between their ARP values.

The results shown in the tables demonstrate that pure exploitation could be observed among all the defined groups since their MRP and ARP have simultaneously exceeded their wages during the period considered. However, the intensity of the exploitation in the groups has been different. In this regard, the intensity of pure exploitation among female workers, according to the obtained results, has been more than male workers. The gap between the female workers' MRP and their wages has been substantial compared to the male workers' gap. The results also indicate that male workers in low-level occupations have been more exploited than male workers in high-level occupations since the gap between their MRP and wages in all the years shown in the tables has been greater than that of the other group. In contrast to the male workforce, the gap between female workers' wages and MRP in high-level occupations has been greater than the other group's gap.

5. Conclusion

As stated above, what can have a significant impact on the profitability level in a firm is the wages of workers employed by the firm since the firm will be able to make huge profits if it exploits the workers. In contrast to the firm, the workers' wage exploitation can adversely affect the workforce's livelihoods. Due to the adverse effects of wage exploitation on workers' welfare, this study aimed to empirically evaluate the concept of pure neoclassical wage exploitation in Singapore from 2011 to 2018. Furthermore, the study presumed that workers are heterogeneous. Due to the presumption, workers were stratified by their gender (female and male workers), and the gender groups were also categorized into high-level and low-level occupations. The differentiation among workers was conducted by the Cobb-Douglas production function, whose labor input took the form of the CES function. The existence of pure exploitation among the workers was evaluated in three steps. First, the production function explained above was estimated during 1980-2018 to obtain coefficients and parameters required to calculate the workers' MRP. Second, the MRP and ARP of the defined groups were calculated. Finally, the workers' wages were separately compared to their annual real wages from 2011 to 2018.

The empirical results indicate that the MRP and ARP of female groups have surpassed those of their male counterparts. Although the MRP of workers in high-level occupations has exceeded the figure for the workforce in low-level occupations, the ARP of workers with low-level occupations has been greater than that of workers with high-level occupations. This study's findings also demonstrate that pure exploitation has occurred among all of the examined groups because the values of MRP and ARP for all of the workers have exceeded their annual real wages. In comparison with male groups, the gap between female groups' wages and their MRP has been substantial, and the issue reveals that more wage exploitation has been imposed on the females. Furthermore, the results obtained about the occurrence of wage exploitation in the occupational groups (high-level and low-level occupations) were different between the gender groups (female and male workers). This is because male workers with low-level occupations have been more exploited than the

males working in high-level occupations. In contrast, the degree of exploitation of the females working in high-level occupations has been greater than that of women with low-level occupations.

It is evident from the results that pure exploitation has occurred among the working groups examined in the model of this study. Based on the findings, some policy implications can be drawn to eliminate wage exploitation. Hence the competition in the product and labor markets should be promoted by supporting laissez-faire policies to break the monopolistic position of firms influencing the wages of their workforce. Moreover, it is undeniable that trade unions can play a key role in reducing the gap between wages paid to workers and their MRP, provided the unions' bargaining power improves. Therefore, the establishment of strong trade unions should be endorsed by the government. Finally, information barriers that act against workers ought to be broken down to enhance competition in the labor market.

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